

of New York, and *Lepidodendron karakubense*, another very closely allied species, which may perhaps belong to *Protolopododendron*, comes from the Upper Devonian of the Donetz Basin.

The Yalwal species form an interesting addition to our knowledge of Devonian floras in New South Wales, and it would be of considerable interest to know the time relation of the rocks in which they were found, to those in which *L. australe* occurs.

The few specimens here described indicate an Upper Devonian age for the rocks at Yalwal in which they occur.

PROTOLEPIDODENDRON LINEARE, n. sp. Plate xxiv, figs. 1, 2.

The specimen here described (Geol. Survey of N.S.W., No. 12474) is part of the collection made at Yalwal and referred to in the report on the Yalwal Gold-field by E. C. Andrews (1901, p. 16). It bears such a close resemblance to some figures of *Protolopododendron primaevum* (White, 1907) that little hesitation is felt in referring it to that genus. The specimen consists of portion of the impression of a stem, some 9 cm. wide, in which the leaf cushions are arranged in distinct vertical series separated from one another by straight vertical grooves. The leaf cushions are narrow and elongated vertically, about 5 mm. long by 1.5 mm. wide, and the vertical grooves separating them are about 2 mm. apart; the cushions are not separated from one another vertically by groove or ridge, but merge gradually into the adjacent ones above and below.

In addition to the pronounced vertical series of leaf cushions there is also a definite spiral arrangement, the lines of the spiral making an angle of about 55° with the horizontal.

The leaf cushions are noticeably raised and are somewhat fusiform in shape, the greatest width being rather near the top; many of them show a median vertical ridge terminating upwards in a circular or oval area which is probably the leaf scar. It seems not unlikely that the narrow vertical ridge may represent the position of the vascular strand, made noticeable by removal of some of the surface tissue. No trace of the parichnos is to be seen, but in the centre of the leaf scar there is occasionally a small single scar which probably represents the leaf trace.

The most distinctive features of this fossil are the arrangement of the leaf cushions on series of vertical ridges separated by straight grooves and the absence of any distinct horizontal line of demarcation between adjacent cushions. In both respects it shows remarkably close similarity to some of White's figures of *P. primaevum* from the Upper Devonian of New York (White, 1907, especially Plates 9 and 10). The regular vertical arrangement of the leaf cushions is a character in which it resembles some types of *Sigillaria*, whilst the elongate-rhomboid or fusiform shape of the leaf cushion shows greater resemblance to *Lepidodendron*. In *Protolopododendron primaevum* the cushions are somewhat larger than in my specimen (being both longer and wider but having similar general proportions), but in view of the wide geographical separation and the uncertainty of the exact horizon of the New South Wales specimen, as well as the much more complete available knowledge of *P. primaevum*, it is not felt that the Yalwal specimen should be referred to that species.

Our specimen is quite distinct from *Archaeosigillaria Vanuxemi* (Göppert) which Kidston (1899-1900, p. 38) transferred from *Lycopodites* to a new genus,

Archaeosigillaria, which, as White (1907, 339) pointed out, is probably synonymous with *Protolipidodendron*.

In *A. Vanuxemi* the leaf scars are "contiguous, broadly fusiform on younger branches, hexagonal on older stems, having a single vascular cicatrice" (Kidston, 1899-1900, p. 38). The American specimens come from the Upper Devonian (Chemung Group) of New York, and British examples from the lower beds of the Mountain Limestone of Westmorland, probably of the same age as part of the Calciferous Sandstone of Scotland. Kidston's figures (1885) of *A. Vanuxemi* show the Lepidodendroid type of cushion only on young branches, while on branches which are older, but whose diameter is still comparatively small, the cushions are hexagonal as in *Sigillaria*. It is not known whether older portions of the stem from Yalwal would bear hexagonal leaf cushions, but in view of the similarity of arrangement of the cushions in general to that in *Sigillaria* it seems more likely that the stem here described, which would have a diameter of more than 8 cm., represents the older Sigillarioid portion and that the younger portions of the same stem would bear cushions more resembling *Lepidodendron*.

The Rev. W. B. Clarke recorded the presence of *Lepidodendron* and *Sigillaria* in the beds from which the specimen came, and Andrews (1901, p. 16) states that "the *Sigillaria* mentioned by the Rev. W. B. Clarke has not been discovered since"; it seems more than probable that Clarke's record of *Sigillaria* was based on a specimen similar to that described above.

PROTOLEPIDODENDRON YALWALENSE, n. sp. Plate xxiv, fig. 4.

Two specimens (Geol. Survey of N.S.W., Nos. 12475-6) from Yalwal represent a species quite distinct in appearance and in the character of the leaf cushions from *Protolipidodendron lineare* described above, but the two species may ultimately prove to represent different parts of the stem of a single species.

The leaf cushions are Lepidodendroid in general appearance, vertically elongate-rhomboidal, but are in distinct vertical series as well as spiral in arrangement. The grooves separating the vertical series are, however, sinuous and not straight as in *P. lineare*, so that the cushions in the vertical rows do not appear to occupy distinct vertical ridges as they do in that species. The cushions resemble those of *P. lineare* and other species of *Protolipidodendron* in not being separated from the next above and below, each one merging gradually into the adjacent vertical cushions without the interposition of any horizontal ridge or groove. This is a feature by which *Protolipidodendron* may be distinguished from *Lepidodendron*.

The leaf cushions, which are about 7 mm. long and 4.5 mm. wide, have a well-marked raised area, rather nearer the apex of the cushion than the base, forming a transversely rhomboidal or rounded area representing the leaf-scar. There is in places some slight indication of the presence of the leaf trace in this area, but no trace of the parichnos. In the lower part of the leaf cushion there are occasionally a few transverse wrinkles.

In general appearance this species agrees almost exactly with the higher parts of the stem of *P. primaevum* (White, 1907, Plate 11) in which, however, the leaf cushions are longer but narrower than in our species. The same reasons might be given for not identifying our specimens with White's species as were given in the case of *P. lineare*, described above. It may be that *P. yalwalense* and *P. lineare* represent different parts of the stem of a single species, since *P. primaevum* shows the two types of structure at different levels of the one stem,

but it may be pointed out that the type of leaf cushion exhibited by *P. yalwalense* occurs in *P. primaevum* at a higher level of the stem than does the type shown in *P. lineare*. One would expect the leaf cushions in the higher parts of the stem to be smaller than those lower down; the cushions in *P. yalwalense* are considerably larger than in *P. lineare*, which, added to the fact that the specimen of the latter species is not a very small stem (judging by the curvature it would be at least 8 cm. in diameter), gives some justification for specific separation of the specimens from Yalwal.

A plant very like *P. yalwalense* is *Lepidodendron karakubense* Schmalhausen (1894, p. 33, t. 2, f. 13, 14) from the Upper Devonian rocks of the Donetz Basin, which has similar leaf-cushions in vertical series separated by sinuous grooves and which also exhibits the absence of distinct demarcation between the cushions in a single vertical series. *L. karakubense* has been redescribed and refigured by M. D. and G. Zalessky (1921) who had more complete material and were able to describe petrified stems. This species and *P. yalwalense* show some resemblance in general appearance to *L. Veltheimianum*, but there is a clear distinction in the definite vertical arrangement of the leaf-cushions in *P. yalwalense* and *L. karakubense*, as well as the absence of horizontal separation of adjacent cushions in the same vertical row.

The specimen of *Protolopodendron Karlsteini* described by Lang (1926, 790) from the Middle Old Red Sandstone of Scotland is a much smaller stem than that from Yalwal, but the shape of the leaf-cushions is similar. In the Scottish specimen, however, the cushions in a vertical series are not so close together, being connected by comparatively long narrow areas sometimes as much as half the length of the cushions themselves. This makes the two species quite distinct in surface appearance.

(?) *LEPIDODENDRON CLARKEI*, n. sp. Plate xxiv, fig. 3.

A specimen from Yalwal (Geol. Survey of N.S.W., No. 12477) consists of a cast of a stem impression, 5 cm. wide, in which the leaf-cushions are very regular in size, rhombic in shape, averaging about 3.5 mm. transverse diameter and 3 mm. vertically, and sharply marked off from one another by well-defined wide diagonal grooves which show as ridges in the cast. The leaf scar is small, situated on a prominently and rather sharply raised projection close to the upper angle of the cushion (from one-sixth to one-third of the length of the diagonal from the apex).

This specimen has the general appearance of *L. australe* except that the leaf-cushions are very much smaller than in that species even though the stem is by no means a small one. Stems of *L. australe* which have leaf-cushions at all approximating the small size of those in this specimen are all comparatively thin; I have before me a branching stem of *L. australe* which is considerably thinner than the specimen here described and which has leaf-cushions averaging about 5 mm. by 5 mm., as well as a second example of the same species, 6 cm. wide (about the same width as the Yalwal specimen), in which the cushions average 8 mm. \times 9 mm. Both the examples mentioned are normal specimens of *L. australe*. In addition to this marked difference in the size of the leaf-cushions, it is apparent that the leaf-scar in the specimen from Yalwal was situated on a prominently raised area of the cushion, whereas there is no evidence to show that this was the case in *L. australe*.

The specimen described shows some resemblance to a number of other species, and, in the absence of details of structure, it is referred to the genus *Lepidodendron* only provisionally. Specimens from the Lower Coal Measures of Missouri described and figured by White (1899, p. 218, Pl. 65-68) as *Omphalophloios cyclostigma* (Lesquereux) are very similar in general appearance to (?) *Lepidodendron Clarkei*, but the Missouri specimens are larger, and the absence of details of the structure in my specimen makes it impossible at present to say whether the two are identical. Another similar species is *Omphalophloios anglicus* Kidston (see Seward, 1910, p. 197, fig. 193c) from the Upper Coal Measures of Somerset, but this shows distinct vertical grooves and a vertical arrangement of the leaf-cushions which are not evident in the Yalwal specimen. There is also some resemblance in general appearance to some varieties of *Sigillaria Brardi*, a species occurring in rocks of Upper Carboniferous and Permian age (cf. Seward, 1910, fig. 203, p. 225). Further there is the genus recently described by Hörich (1915, p. 426) as *Phialophloios*, of which the species *P. quadratus* has similarly shaped leaf-cushions with the scar at the lower angle of the cushion; the specimen from Yalwal shows a considerable degree of resemblance to *Phialophloios quadratus*, as also do many specimens of *Lepidodendron australe*, and all three may possibly be identical, but the Australian species occur in rocks of Devonian age whereas the European *Phialophloios* comes from the Carboniferous.

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EXPLANATION OF PLATE XXIV.

- Fig. 1. *Protolopododendron lineare*, n. sp. Nat. size.
- Fig. 2. *Protolopododendron lineare*, n. sp. (× 2). Portion of Fig. 1 enlarged to show some detail of leaf cushions.
- Fig. 3. (?) *Lepidodendron Clarkei*, n. sp. (× 3/2 approx.).
- Fig. 4. *Protolopododendron yalwalense*, n. sp. Nat. size.